

When AR Meets Food: A Structural Overview of the Research Space on Multi-Facets of Food

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ABSTRACT

Food has always been interwoven with the human life, biologically and emotionally. Recently, there has been growing research interest in the various aspects of food itself and the food-related activities, in both physical and digital format. Yet, the progress made and the key research questions for these researches are rarely analyzed systematically. In this paper, we summarized the characteristics of food from different perspectives and provided a survey of existing works. We categorized the functions of food into biological, psychological and cultural, and described how augmented and mixed reality technologies have been applied to various aspects of food. We then discussed about the structural research space based on the literatures to address the opportunities and challenges for further development around augmented food experience. The main purpose is to highlight the expressiveness of technology-enhanced food and engage people's emotional perception and experience with food.

Keywords: Food, Augmented Reality, smell, taste, entertainment.

Index Terms: H.5.m [Information Interfaces and Presentation (e.g., HCI)]: Miscellaneous

1 INTRODUCTION

The topic of food is widespread over the world and popular in various research domains. Food is a central part of human life, beyond feeding people with energy and nutrition; it is also symbolically interwoven with human society, art, media, entertainment, and culture as well. Previous HCI researches related to food situated in different settings, like restaurant, kitchen, dining table, market, and mainly involved food cooking and eating, locally and remotely. Furthermore, food is also becoming a theme of particular fascination in game design, the digital games that use computer-generated graphics and animations to simulate the food cooking, selling or eating activities in virtual environments.

On the other hand, Augmented Reality (AR) technology is recently undergoing significant growth and has been applied in numerous fields. AR enhances and modifies our perception of reality by presenting computer-generated virtual sensations in semantic context with real environmental elements. The majority of current AR applications are visual-based. However, AR has great potential to augment perceptions other than vision, and researches have been performed towards augmented audio, touch, even smell and taste, which contributes to enhanced user perception and enriched user experience.

The intersection between AR and food is noticeable. Current examples of Augmented Reality related to food include displaying

additional background information of food in digital format over the real object, creating 3D visualizations of food through its photos [2], studies that use AR to shape the food selection and purchase experience both online and in real life [11], using computer generated food and restaurant as therapy for eating disorders [1] or as a tool for study the food addictions [8]. Other researches include changing apparent size of food using Head Mounted Display (HMD) device, inducing cross-modal tasting effect using by the developed pseudo-gustation system [9], and so on. With the expanding usage of Smartphone, there have been a growing number of various mobile applications in the market that combine augmented reality with social networks and location-based functions to shape the personal and social experience related to food, connecting people via food with higher convenience and engagement.

In spite of the inventiveness and significance of these examples, we see a number of limitations. At first, most of the current research typically concentrated on the technical aspect, rather than the roles that food play in these applications; specifically, the benefits of using food, and the psychological or emotional effects on people from augmenting food. In these interesting works, questions like why food was used in these situations and what made food the distinctive medium were not clearly presented. Secondly, the importance of interactivity and internal cultural meanings of food has not been much explored. This paper takes an overview of the research that specifically applied AR technologies on food and food-related activities, so as to put existing work into perspective and identify under-explored areas.

Food is integrated with multiple sensational elements that make it unique from other common objects, not only involves visual, but also tactile, smell and taste feelings. But limited efforts have been focused on augmenting these unique features and experience of food. Our goal in this paper is to illustrate the research works that have been carried out around augmented food in an analytical way, not from the technical perspective, but based on our analysis of food, regarding the content they augmented, method and purpose respectively. We think the extraction of food characteristics and analysis with current technologies can help to uncover the potential areas for future development and broaden the relevant research towards enriched pleasurable experience for people from their everyday environments.

2 OVERVIEW OF FOOD

Food is pervasive. Biologically, humans need food to survive and get energy. Beyond that, food consuming is also in the fabric of people's everyday life, and is charged with intense and complex relationship with people's emotional feelings.

In this paper, we categorized the functions of food into three main groups: biological, psychological and cultural, reaching from individual to social level, and finally racial level. However, these three functions are not mutual exclusive, but are interrelated with each other in different manners. For the psychological function, the emotional feelings can be derived from food itself, or during the food-related activities.

As mentioned, food is multi-purpose and multi-facet. It is distinctive for its organic nature, and the rich varieties that have strong cohesion with human senses, including texture, color,

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smell, taste, temperature, acidity, moisture and appearance. The richness features makes it potential to be utilized, augmented with technologies and applied in different domains. Contrary to the real edible food, we defined “virtual food” as the “digital representation of food”. Examples include the pictures of real food on social network sites, animated food in video games, etc.

Both categories of food have properties that can be identified visually, like shape, color and texture, since they are easier to be captured and presented. Using vision technologies like tracking and recognition, combined with AR, virtual food can sometimes present more layers of information than the physical food itself, for example the detailed nutrition data, the comparison with other similar food, and customized food recommendation. As for the other exclusive features that related to human senses except visual, they can be difficult to be achieved virtually same as the original feeling, but can still be represented by visualizing through data, graph and light to indicate the differences.

Food is not standalone but related to a series of activities. Not only food itself, mixed and augmented reality has also been applied into different stages of food-related activities, either to enhance the efficiency or enjoyment of the food experience. The pool of food activities encapsulate the broad spectrum from planting to serving, and the main target ones include store, select, prepare, cook, eat, serve and share.

3 TYPES OF AUGMENTATION

Augmented Reality blends real-world with computer generated digital world, such as 3D graphics or information overlays. Various researches and developments have been carried out around augmented food, regarding the food information, sensational feeling of food, and food-related activities.

3.1 Deliver Increased Information

The first group focused on providing access to additional food information using augmented reality, such as the nutrition, calories, price and quantity data, recommended recipe with the food, or the story behind the food, to increase people's awareness of certain food in different situations. When integrated with the location tracking, these can also achieve to locate the organic food, best rating restaurant, getting access to promotion of food according to the certain position, etc.

3.2 Augmented Sensation

Edible food is a multimodal object combined with a variety of characteristics beyond pure information. All of them are related to human senses and can be difficult to measure, display or convey through vision, but are quite potential to enhance the corresponding experience through manipulating, intensifying, blending or interchanging the sensible aspects. Essentially, food involves many sensory, aesthetic and emotional experiences, and AR can potentially apply to all senses, augmenting smell, touch and hearing as well [5]. Food Texture Display realized the virtual presentation of biting through generating a force on the user's teeth, displaying food texture based on the different forces when biting different real food [3]. Similarly, the Straw-like User Interface achieved the virtual sensational feeling of drinking by following the simple principle of “record-and-replay” [12]. Chewing Jockey extended biting to chewing, and augmented the sensation of food texture by using added sound based on the cross-modal effect [7].

Smell is another significant feature of food. Most previous research focused on the technological developments of virtual olfactory interfaces which can generate and deliver scents without actually smell the original source object, but not necessarily related to food. Such as the virtual olfactory display which used

mainly hardware mechanisms to store, mix and deliver different odorants [6]. Taste is a feature that is exclusive to food. Similar with smell, attempts have been made to develop new taste experiences, stimulate and augment the gustatory information using electronic devices [4], or even creating new taste experience different from the original food, metallic taste, for example. The augmentation of actual human sensations is another form of augmented reality, supplementing not with generated virtual objects, but feeling of existence, which achieves much stronger sense of reality. Particularly for food, this augmentation can alter our experience of eating food in a large degree.

4 DISCUSSION AND CONCLUSION

Food is multi-facet regarding its functions, sensational dimensions, related activities, and attached internal values. Food always comes with rich meanings, cognitively and emotionally. This paper summarizes the features of food, and surveys the current state-of-the-art of technologies, systems and applications in AR applied on food. By organizing those technologies based on the analysis of food, we hope to address some of the ignored internal values of food in computerized augmentation, i.e. the importance of social, cultural and multimodal experience derived from food, the interactivity and entertainment values of food. In general, existing works have mostly been about technology, rather than people's experience and benefits from this augmentation; we hope this paper can complement this by shedding more light on the social and cultural perspectives of food to enrich the seamless experience provided by AR integrated food stuff.

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